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REGION IX
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ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
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Mr. Philip H. Mook, Jr.
Western Execution Branch Chief
Air Force Civil Engineer Center
United States Department of the Air Force

SUBJECT: Former Williams AFB Site ST012, Liquid Fuels Storage Area; Data Needs to
Resolve Informal Dispute over Enhanced Bioremediation

Dear Mr. Mook:

The US Environmental Protection Agency (EPA) and Arizona Department of Environmental Quality (ADEQ), "The Agencies", are in receipt of your February 10, 2017 letter stating Air Force's (AF's) intention to move forward with implementation of the Enhanced Bioremediation (EBR) work plan for ST12, despite the objections raised in our letter to you dated February 8, 2017 and the January 25, 2017 technical responses sent to Cathy Jerrard. In follow up to discussions during the February 14, 2017 Base Closure Team (BCT) meeting, we are hereby providing you with a list of issues, data gaps and missing information needed to resolve the informal dispute over the path forward for the former Fuels Spill Site, attached to this letter.

The Agencies invoked informal dispute over the AF's proposed work plan on the basis that:

- 1) The Steam Enhanced Extraction (SEE) System was prematurely terminated before performance criteria specified in the work plan had been met. For example, the Final RD/RA Work Plan specified transition criteria of mass removal rate less than 10% of the peak removal rate; instead mass removal rates were still as high as 25% of the peak mass removal rate when the SEE system was terminated. AF's explanation that most of the mass was coming from outside of the Thermal Treatment Zone should not affect the transition criteria, given that AF was well aware that there was LNAPL mass outside of the thermal treatment zone when the performance criteria was specified for the SEE system as it was designed. The only conclusion we can draw our evaluation of transition criteria is that the SEE system was not only under-designed to address the LNAPL mass that was actually present but also terminated and dismantled over agency objections before the transition criteria specified in the 2014 Final RDRA Work Plan had been attained.

- 2) The estimates of mass remaining post SEE are too great to expect EBR alone to meet the Remedial Action Objectives (RAOs) specified in the 2013 Record of Decision Amendment (RODA) within the 20-year timeframe specified in the RODA.

3) The site has been heated to boiling temperatures and can be expected to remain hot for many years, and thus, contaminants are now significantly more mobile than they were before SEE. In addition, sulfate can act as a surfactant and could further increase the migration of LNAPL.

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- 4) The mass of remaining petroleum hydrocarbon Light Non-Aqueous Phase Liquids (LNAPL) will be a persistent continuing source of dissolved phase benzene groundwater contamination for decades to come.
- 5) Enhanced Bioremediation can only be expected to significantly degrade the contaminants of concern (COCs) in the dissolved phase, so the rate of COC/LNAPL dissolution is likely to be the rate-limiting step, as indicated by AF; the presence of large accumulations of LNAPL (e.g., as indicated by continuing significant mobilization of LNAPL into wells) means that COC/LNAPL dissolution into groundwater from these LNAPL accumulations will be slow and long-term due to long diffusion paths from within LNAPL accumulations into groundwater; also, benzene, the primary COC, is likely to be the slowest of the BTEX compounds to biodegrade, perhaps allowing benzene to travel farther downgradient before degradation.
- 6) Consistent distribution of EBR reagents throughout the LNAPL zone will be technically challenging due to variations in stratigraphy, hydraulic conductivity, and LNAPL presence; will be difficult to achieve and will also be exacerbated/hindered due to biofouling issues already observed at the site.
- 7) If the rate of natural or enhanced biodegradation is slower than the rate of groundwater contaminant transport an enlarged downgradient benzene groundwater plume will result that will be costly to address in the long term.
- 8) The large quantities of sulfate amendment expected to be added under the proposed work plan are also expected to degrade water quality downgradient of the site if not contained.

Commented [dCK1]:

Commented [dCK2]: ADEQ comment – Dan do you agree? I think I brought this concern up initially, and we discussed it, but don't remember if we concluded that sulfate injection had significant potential to enhance offsite migration.

The bugs would be expected to produce surfactants, which would likely increase dissolution of COCs from LNAPL into GW, but I doubt that LNAPL mobility itself would be greatly increased.

The agencies are not only concerned that the proposed work plan for EBR will likely fail to meet the RAOs specified in the RODA, but also will worsen downgradient groundwater conditions. In your letter of July 1, 2016 and our subsequent telephone conversations, AF initially agreed to discontinue procurement for EBR pending resolution of the dispute and to instead proceed to characterize the remaining contamination and to construct a hydraulic containment system. We are dismayed to learn following the February 14, 2017 BCT meeting that AF has since reversed its position and no longer intends to complete the characterization or operate the containment system as constructed for hydraulic containment as documented in the Remedial Action Field Variance Memorandum #5 – Extraction and Treatment System Construction, dated September 30, 2016. It appears that AF has misled the agencies and instead of the containment system,

constructed the EBR injection and distribution system we had requested be put on hold pending resolution of the dispute.

In the February 14, 2017 BCT meeting AF also indicated the intent to reduce the frequency of monitoring of the downgradient perimeter wells, despite concerns raised by the Agencies that monitoring data and rising temperatures in perimeter wells are already beginning to demonstrate loss of hydraulic containment. The agencies continue to believe that hydraulic containment should be initiated as soon as possible to avert the downgradient mobilization of contaminants.

These reversals of prior agreement appear to contradict AF's stated commitment to the remedial objectives at ST-12. Based upon responses to the concerns raised by the agencies, we are unsure at this time if the AF cares whether the proposed EBR remedy will be effective or not given the uncertain long timeframe and vagueness of approach to attainment of remedial objectives presented in the work plan.

The agencies are still committed to the FFA process and hope that AF will continue negotiations in good faith to resolve this dispute. Please advise if we have misunderstood or misrepresented AF's current position.

Sincerely,

Angeles Herrera
Assistant Director
Superfund Division
United States Environmental Protection Agency
Quality

Tina LePage
Waste Programs Division
Remedial Projects Section Manager
Arizona Department of Environmental

cc:

Issues and Data Needs to Approve the Addendum 2 RDRA Work Plan and Resolve the ST12 Informal Dispute

Issues:

- 1) The May 2014 Final RDRA Work Plan specified that once SEE was terminated, the wells in the cell phone lot would be connected to the SEE extraction system via underground piping in order to reopen the cell phone lot and that post SEE extraction would continue for 90 days. (Page 4-10) However, the extraction system was abruptly terminated and rapidly dismantled after only 8 weeks of post SEE extraction. No technical rationale has been provided for these changes to the Work Plan. Please provide AF's technical basis for termination of the extraction system at only 8 weeks.
- 2) Long term hydraulic containment was included in the original proposal for EBR as stated in this work plan. The first sentence of Section 4.0 of the Modeling Report (Appendix E of the work plan) states, "The approach to remediating the LNAPL impacted zones outside the SEE treatment zones combines the technologies of groundwater recirculation with the addition of TEA, and plume containment . . .". Plume containment is also discussed throughout the EBR implementation plan. Please provide AF's technical basis for removing hydraulic containment from the RDRA Work Plan Addendum 2.
- 3) The January 2014 Draft Final RDRA Work Plan Appendix E specified an EBR injection design utilizing a 5 point pattern of injection well design utilizing a 60 foot well spacing, and stated "*Beyond an approximate well spacing of 75 feet results from the model revealed that sufficient extraction pumping could not be achieved because of limitations associated with the permeability and storage of the aquifer and subsequent loss of injectate to the natural gradients in these gaps between extraction well capture zones.*" (Appendix E page 4-1; Section 4.1) The 2014 Work Plan proposed a total of 61 wells for amendment injection or extraction, including 5 in the Cobble Zone (CZ), 28 in the Upper Water Bearing Zone (UWBZ), and 28 in the Lower Saturated Zone (LSZ). (Appendix E pages 4-2 - 4-4) These 61 wells appeared to be necessary to attain optimal amendment distribution to meet remedial objectives in the 2014 Draft Final RDRA Work Plan. In contrast, the design proposed in the March 2016 Addendum 2 Work Plan employs only 27 wells for amendment distribution, spaced more widely apart than the 2014 model recommendation, placed to treat the perimeter areas and does not appear to be designed to reach LNAPL remaining in the interior of the site. The Field Variance Memorandum #5, Final January 2017 documents a constructed network of 18 perimeter wells, presumably for hydraulic containment as indicated in that document, but AF has since indicated these are now planned solely for implementation of EBR. Please provide the technical basis to explain the downscaling of the EBR effort with each successive work plan draft.

- 4) The May 2014 work plan called for the injection of 7,600 tons of sulfate to treat the estimated 465,000 gallons of LNAPL remaining after SEE. Although the estimated mass remaining after SEE did not significantly change in Addendum #2, the amount of mass of sulfate to be injected was reduced to 860 tons. Please explain the rationale for reducing the amount of sulfate to be injected.
- 5) The January 2014 Draft Final RDRA Work Plan provided preliminary performance criteria of implementation of EBR in table E-4.15, which specifies milestones to be attained in benzene concentrations within specific timeframes. However, we found no performance criteria specified in the March 2016 Draft Final RDRA Work Plan Addendum 2. Normally we would expect the earlier plan to be more conceptual and less specific than the later versions of the document, but it appears that in this case the objectives and performance criteria have become less specific as the scope of the proposed effort has been scaled back over time. The objectives of the current proposed effort are unclear at this time. Please clarify whether AF is still committed to the performance milestones stated in the table below, and demonstrate how the current reduced effort is will be capable of attaining these objectives:

Table E-4.15 Predicted Maximum and Average Dissolved Benzene Concentrations Following Sulfate-Reducing EBR

Hydrostratigraphic Zone	Date (month/year)	Predicted Benzene Concentration (µg/L)		Notes
		Average	Maximum	
Cobble Zone	04/2017	21	27	End of EBR Recirculation/TEA Addition
	04/2025	1.25	7.8	~8 years following EBR
	01/2031	0.08	0.95	~15 years following EBR
Upper Water Bearing Zone	04/2017	210	1,400	End of EBR Recirculation/TEA Addition
	04/2025	5.5	9.5	~8 years following EBR
	01/2031	1.0	3.3	~15 years following EBR
Lower Saturated Zone	04/2017	31	270	End of EBR Recirculation/TEA Addition
	04/2025	1.9	6.9	~8 years following EBR
	04/2031	0.64	2.8	~15 years following EBR

Notes:
 ~ - approximately
 µg/L - micrograms per liter
 EBR - enhanced bioremediation
 TEA - terminal electron acceptor

Immediately following sulfate-reducing EBR recirculation (Table E-4.15) the model predicts that dissolved benzene concentrations are below approximately 27 µg/L in the CZ, 1,400 µg/L in the UWGZ, and 270 µg/L in the LSZ. Within eight years following sulfate-reducing EBR dissolved benzene concentrations drop and the maximum concentration of benzene predicted in the UWGZ is 9.5 µg/L. By 2031, the benzene concentrations in each of the hydrostratigraphic zones are predicted to be below 5 µg/L.

- 6) A review of the limited model description contained in Appendix E of the Work Plan reveals that the model overestimated degradation rates by assuming that sulfate injection

concentrations greater than 2 grams per liter (g/L) would result in higher degradation rates, by not taking into account inhibition due to sulfate concentrations being in excess of 2.5 g/L, by not taking into account higher utilization rates for compounds such as toluene and xylene, and by assuming that degradation was instantaneous for compounds in the dissolved phase. Please revise the model using realistic input values and provide references for assumptions used in the model.

Commented [WU3]: We'll probably get pushback on these, so we need to have strong documentation lined up to validate these concerns.

Data Needs to resolve the dispute:

- 1) Because several different versions of the Addendum 2 Work Plan have been provided and each successive version appears to document a reduced effort and commitment, all of the information relevant to the current proposal needs to be provided in a single document.
- 2) The current remaining mass estimate still needs to be verified by post SEE sampling. Baseline conditions identifying specific locations and depths of NAPL bodies and benzene concentrations remaining in LNAPL by location is needed to be able to target areas for treatment and evaluate remedy performance. ~~Locations within the former thermal treatment zones (TTZs) should be included as LNAPL continues to appear in former SEE process wells. The current mass estimate assumes a 90% reduction in BTEX+N content in the former TTZs based on experience from other sites; however, no references, citations, or site names were provided in response to previous comments from the regulatory agencies. However, the ST12 SEE system was terminated before the less than 10% of peak performance objective was attained, and LNAPL has reappeared in wells.~~
- 3) Please provide an evaluation of amendment mass loading effects on groundwater chemistry over time, taking into account groundwater transport.
- 4) Please provide an updated estimate of a realistic timeframe to meet the remedial action objectives under the current proposed effort. Please provide all modeling efforts and assumptions in a complete package, including all inputs and outputs of the model for each iteration of the model over the years, and all calibration efforts and sensitivity analyses. In particular, because the movement of COCs from within the LNAPL into groundwater is considered to be the rate-limiting step for EBR, please provide a discussion of how COC movement from LNAPL to groundwater was evaluated in the model, and how sensitivity analyses of this movement rate were conducted.
- ~~5) Please specify the milestones proposed to be used to monitor success of the EBR against baseline conditions and describe how performance monitoring will be used to demonstrate attainment of milestones and remedial action objectives.~~

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Commented [dCK4]: Don't think performance at other sites where thermal was run allowed to run to completion are relevant comparisons.

5) Please provide a revised monitoring plan based on results from the post-SEE characterization program. The monitoring plan should include more wells in the interior of the plume, if temperatures allow.

6) Baseline monitoring should include investigation of the current indigenous microbial population.

—Please specify the milestones proposed to be used to monitor success of the EBR against baseline conditions and describe how performance monitoring will be used to demonstrate attainment of milestones and remedial action objectives.

7)

Commented [WU5]: And maybe "decision points and criteria for EBR remedy failure/implementation of contingency remedies,"

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